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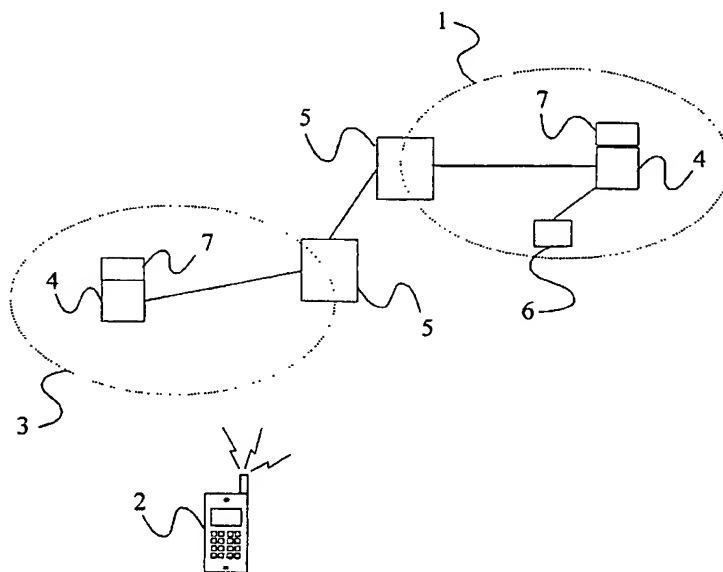
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- For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.*

(54) Title: CHARGING CONTROL IN A MOBILE TELECOMMUNICATIONS SYSTEM



(57) Abstract: A method of controlling charging for a subscriber (2) of a home network (1) when the subscriber is roaming in a foreign network (3). Subscribers (2) are registered with the foreign network (3) with the registration process involving the transfer, from the home network (1) to the foreign network (3), of one or more charging events predefined for the subscriber (2). In the event that a charging event occurs for the subscriber (2), a corresponding notification message is sent from the foreign network (3) to the home network (1). Thereafter, the home network (1) is able to terminate the subscriber's registration with the foreign network (3) and/or restrict the subscriber's access to network services.

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CHARGING CONTROL IN A MOBILE TELECOMMUNICATIONS SYSTEM

Field of the Invention

- 5 The present invention relates to charging control in a mobile telecommunications system and in particular to charging control for subscribers who are roaming in a foreign mobile network.

Background to the invention

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In today's mobile telecommunications networks, the operator of a mobile network is able to maintain tight control over the calls made and services used by its subscribers when they are at home, i.e. when they are registered with the operator's own network. For example, if a subscriber exceeds his calling credit limit the operator can notify the subscriber of this situation and/or can prevent the subscriber from making further calls until his outstanding account is settled. Similarly, where a subscriber makes use of a top-up account, e.g. using scratch cards to credit his account, an operator can restrict the subscriber's access when the subscriber's credit drops to zero.

- 20 Such charging control is possible because the Mobile Switching Centre (MSC) which acts as the "local exchange" for a subscriber sends Charging Data Records (CDRs) at regular intervals to a charging node of the subscriber's home network. However, this is only possible when the controlling MSC is an MSC of the home network. Currently CDRs from visited networks are passed to a home network through a clearing house in so-called TAP files. It can take at least two days or even more before the CDRs are forwarded on to home network.

- A home network cannot monitor, in real time or near real time, the charges being incurred by one of its subscribers when that subscriber is roaming in a foreign network.
- 30 Rather, charging information is only sent periodically from the foreign network to the home network (e.g. every few days). There therefore exists a possibility that fraud by a roaming subscriber will go undetected by the subscriber's home network for some time. and that during that time the home network operator will incur considerable losses.

A direct consequence of fraud by roaming subscribers, or of fraud by counterfeit subscribers, is that mobile network operators often prevent certain categories of subscribers from using the roaming service. For example, users of top-up accounts are
5 generally prevented from roaming. This situation is unacceptable to many potential subscribers.

Summary of the Present Invention.

10 It is an object of the present invention to overcome or at least mitigate the above noted disadvantages. In particular, it is an object of the present invention to provide cost and fraud control for all roaming subscribers in real time or close to real time. It is also an object of the present invention to provide a method for transferring charging related information between a foreign network and a home network.

15

According to a first aspect of the present invention there is provided a method of controlling charging for a subscriber of a home network when the subscriber is roaming in a foreign network, the method comprising the steps of:

20 registering the subscriber with the foreign network including transferring from the home network to the foreign network one or more charging events predefined for the subscriber; and

in the event that a charging event occurs for the subscriber, sending a corresponding notification message from the foreign network to the home network, wherein the home network is subsequently able to terminate the subscriber's registration
25 with the foreign network and/or restrict the subscriber's access to network services.

It will be appreciated that by predefining certain charging events for a subscriber and providing these to the foreign network, the subscriber's home network can be notified of certain events which are significant *vis-à-vis* charging. This is a much more efficient
30 method for example than transferring CDRs from the foreign network to the home network even if this were possible.

Examples of charging events which may be predefined for a subscriber include; initiation of a telephone call, initiation of an international call, and a call exceeding a predefined duration.

- 5 Preferably, the charging event information for the subscriber is held at a Home Location Register (HLR) of the home network. The subscriber may be identified at the HLR by a unique International Mobile Subscriber Identity (IMSI).

- 10 Preferably, the or each charging event is transferred from the home network to a switching centre of the foreign network which is responsible for the subscriber. More preferably, the switching centre is a Mobile Switching Centre (MSC) or a GPRS Support Node (GSN).

- 15 Preferably, charging events and/or event notifications are transferred between the home network and the foreign network using a traffical protocol. More preferably, the traffical protocol is the Mobile Application Part (MAP) protocol. Alternatively, in a General Packet Radio Service (GPRS) network, the GPRS Tunnelling Protocol (GTP) may be used.

- 20 According to second aspect of the present invention there is provided apparatus for controlling charging for a subscriber of a home network when the subscriber is roaming in a foreign network, the apparatus comprising:

a register for use within the home network and having memory means for storing one or more charging events predefined for the subscriber;

- 25 registration means for use within the foreign network and arranged to register the roaming subscriber by contacting said register of the home network to obtain said charging event(s);

- notification means for use within the foreign network and arranged to notify the home network in the event a charging events occurs for the subscriber, wherein in use
30 the home network is subsequently able to terminate the subscriber's registration with the foreign network and/or restrict the subscriber's access to network services.

Brief Description of the Drawings

Figure 1 illustrates schematically a telecommunications system embodying the present invention; and

Figure 2 is a flow diagram illustrating a method of controlling charging in the system of

5 Figure 1.

Detailed Description of Certain Embodiments

There is illustrated in Figure 1 a telecommunications system comprising two
10 interconnected Public Land Mobile Networks (PLMNs). For the purposes of the following illustration, a first of the PLMNs 1 represents the home network of a subscriber using a mobile terminal 2, and is referred to as the Home PLMN (HPLMN). The second of the PLMNs 3 is referred to as the Visited PLMN (VPLMN). Both networks are Global System for Mobile communications (GSM) based networks and
15 comprise a number of Mobile Switching Centres (MSCs) 4. The networks 1,2 are coupled via respective Gateway MSCs (GMSCs) 5. Each network also comprises Base Transceiver Stations (BTSs) and Base Station Controllers (BSCs) which serve as the interface between mobile terminals and MSCs, although these are omitted from Figure 1.

20

Both of the networks comprise a Home Location Register (HLR) 6 although this is only illustrated in Figure 1 for the HPLMN 1. The HLR 6 maintains a record of all of the subscribers of the HPLMN 2, including the International Mobile Subscriber Identity (IMSI) for each subscriber and which is used by a subscriber to register with a network.
25 For each subscriber, the HLR 6 has the option of recording one or more so-called "calling events". The function of a calling event will be described further below.

Associated with each MSC 4 is a Visitor Location Register (VLR) 7 which maintains a record of subscribers currently registered with the associated MSC 4. The record
30 includes subscribers for whom the MSC 4 is a home MSC, as well as subscribers for whom the MSC 4 is a foreign network. In the event that the subscriber using the terminal 2 roams outside of the coverage area of his HPLMN 1 and into the coverage area of the VPLMN 3, his terminal 2 will seek to register with an MSC 4 of the

VPLMN 3 after the MSC 4 has determined that the subscriber is a foreign network and has not already been registered in the associated VLR 7.

The registration process is initiated by the terminal 2 sending to the controlling MSC 4 his IMSI. In order to authenticate the subscriber, the MSC 4 uses the Mobile Application Part (MAP) protocol to send a MAP_UPDATE_LOCATION message to the HLR 6 of the subscriber's HPLMN 1 (the HPLMN 1 is identified by a prefix part of the IMSI). Assuming that the HLR 6 verifies the IMSI contained in the message, the HLR 6 returns a MAP_INSERT_SUBSCRIBER_DATA message to the controlling MSC. The returned message also includes any charging events which are recorded by the HLR 6 for the subscriber in question. Examples of subscriber events include; initiation of a telephone call, initiation of an international call, and a call exceeding a predefined duration. In the event that the HLR 6 cannot verify the subscriber, an appropriate message is returned to the controlling MSC 4.

Assuming now that the controlling MSC 4 does indeed receive a MAP_UPDATE_SUBSCRIBER_DATA message from the HLR 6 of the HPLMN 1, the subscriber is registered in the VLR 7. Any received charging events are also recorded in the VLR 7. The controlling MSC 4 uses the Fraud Information Gathering System (FIGS) to monitor the subscriber's activity for the occurrence of any of the charging events notified for the subscriber. FIGS is specified in GSM 01.31 (service requirements) and 02.31 (service description).

For example, if a charging event for the subscriber is the initiation of an international call and the subscriber initiates such a call, the controlling MSC 4 suspends the call set-up process, and sends a CHARGING_EVENT_NOTIFICATION MAP message to the HPLMN 1 advising the HPLMN 1 that the charging event has occurred. The EVENT_NOTIFICATION message may be a new message defined within the MAP protocol, and may be delivered to the HLR 6 or to some general charging node. If the HPLMN 1 decides to terminate the subscriber's connection, it may return to the controlling MSC a MAP_CANCEL_LOCATION message (which is an Immediate Service Termination function - see GSM 02.32). Other MAP messages may also be defined for instructing the controlling MSC to take other specific actions as well as for

confirming to the HPLMN from the controlling MSC the action taken. The controlling MSC may continue with the set-up process or terminate the subscriber's access depending upon the received message.

- 5 Figure 2 is a flow diagram further illustrating the method described above.

Messages relating to charging events are sent between the HPLMN 1 and the VPLMN 3 using the MAP protocol. MAP is a traffical protocol which enables the real time transfer of charging related information (subject of course to small transmission delays).

- 10 In this way it is possible to monitor the charging related activities of roaming subscribers in a way which does not greatly increase inter-network signalling traffic. Moreover, the possibility to define different charging events for different subscribers provides operators with maximum flexibility.
- 15 It will be appreciated by the person of skill in the art that various modifications may be made to the above described embodiment without departing from the scope of the present invention. For example, rather than GSM networks, the invention may be employed in third generation UMTS networks. It will further be appreciated that the terms used above, e.g. MSC, GMSC, etc, may have different equivalents in UMTS.
- 20 Where the network is a GPRS based network, charging information may be exchanged between Serving GPRS Support Nodes (SGSNs) and Gateway GPRS Support Nodes (GGSNs).

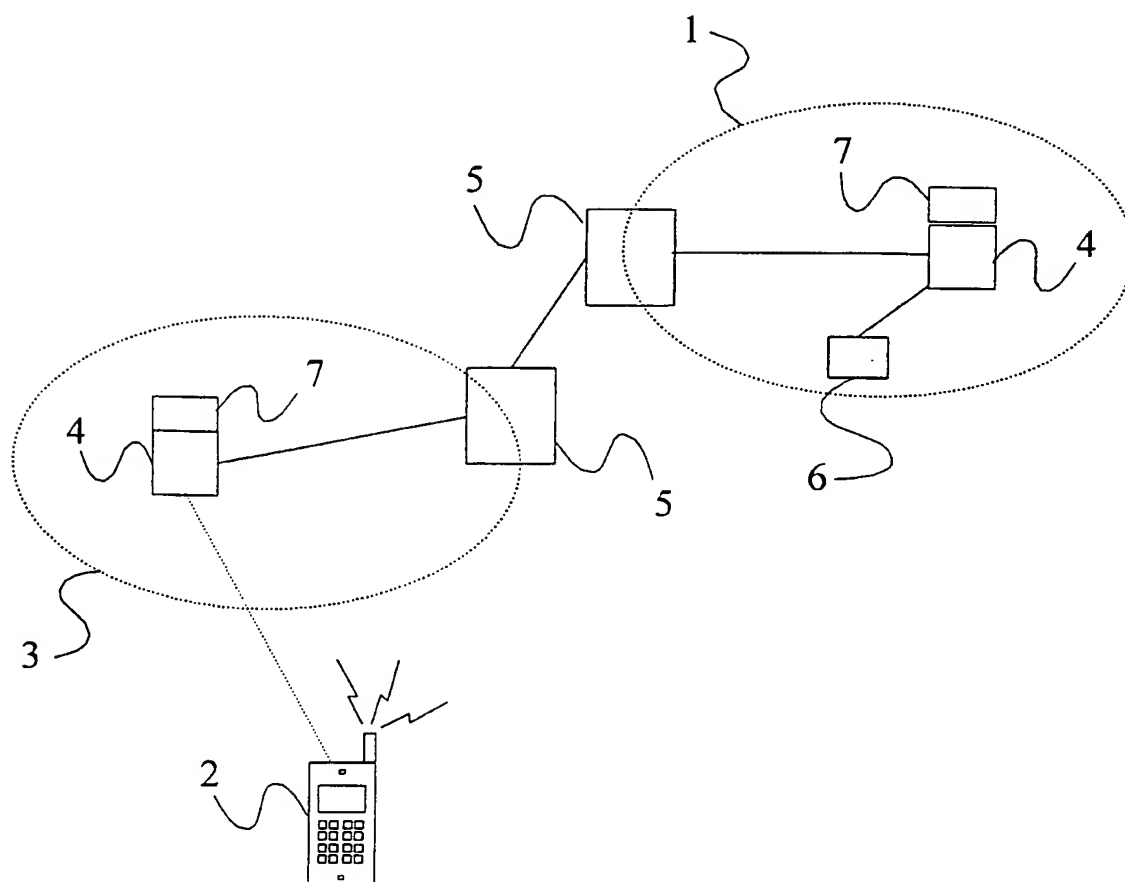
CLAIMS:

1. A method of controlling charging for a subscriber of a home network when the subscriber is roaming in a foreign network, the method comprising the steps of:
 - 5 registering the subscriber with the foreign network including transferring from the home network to the foreign network one or more charging events predefined for the subscriber; and
 - in the event that a charging event occurs for the subscriber, sending a corresponding notification message from the foreign network to the home network,
 - 10 wherein the home network is subsequently able to terminate the subscriber's registration with the foreign network and/or restrict the subscriber's access to network services.
2. A method according to claim 1 and comprising holding the charging event information for the subscriber at a Home Location Register (HLR) of the home network.
- 15 3. A method according to claim 1 or 2 and comprising transferring the or each charging event from the home network to a switching centre of the foreign network which is responsible for the subscriber.
- 20 4. A method according to claim 3, wherein the switching centre is a Mobile Switching Centre (MSC) or a GPRS Support Node (GSN).
5. A method according to any one of the preceding claims and comprising transferring charging events and/or event notifications between the home network and
- 25 the foreign network using a traffical protocol.
6. A method according to claim 5, wherein the traffical protocol is the Mobile Application Part protocol or the GPRS Tunnelling Protocol (GTP).
- 30 7. Apparatus for controlling charging for a subscriber of a home network when the subscriber is roaming in a foreign network, the apparatus comprising:
 - a register for use within the home network and having memory means for storing one or more charging events predefined for the subscriber;

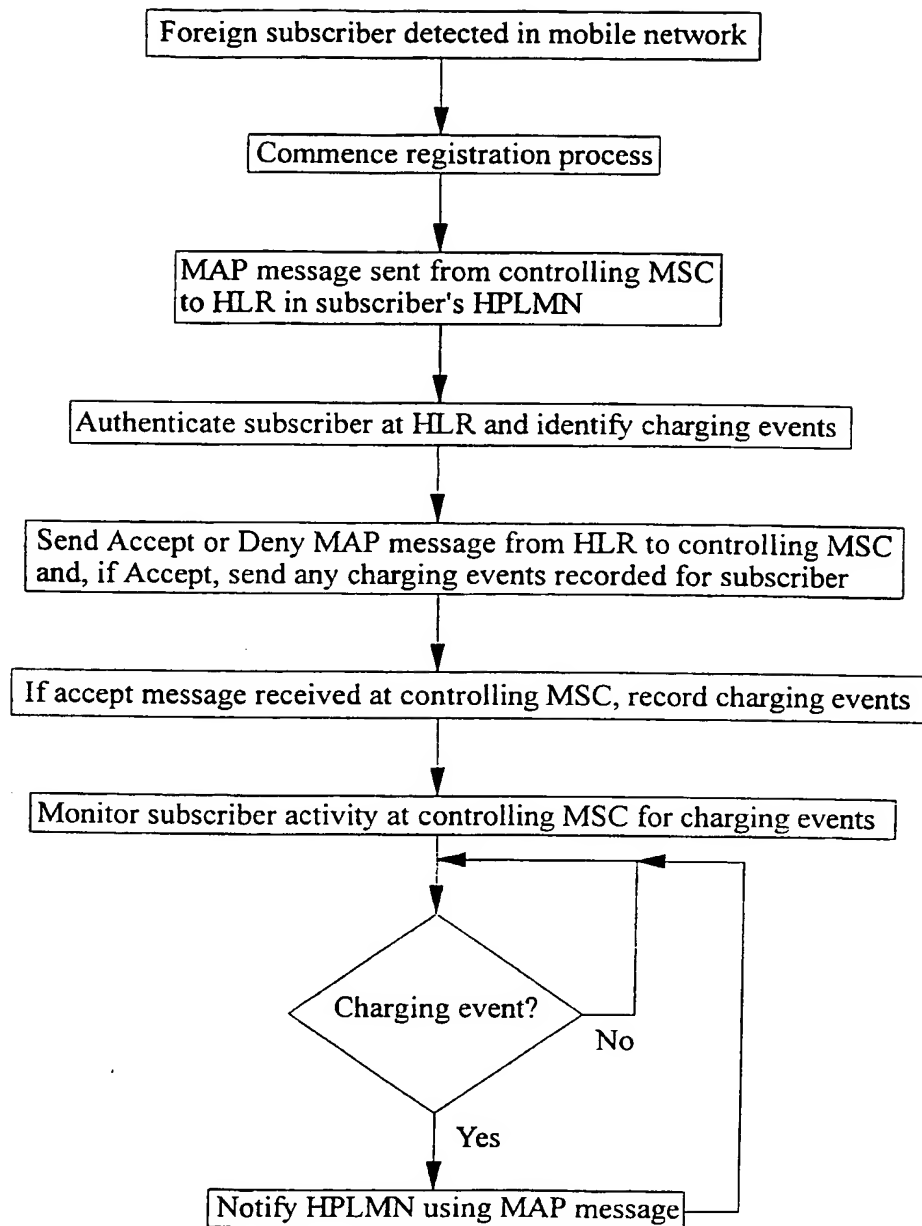
registration means for use within the foreign network and arranged to register the roaming subscriber by contacting said register of the home network to obtain said charging event(s);

- 5 notification means for use within the foreign network and arranged to notify the home network in the event a charging events occurs for the subscriber, wherein in use the home network is subsequently able to terminate the subscriber's registration with the foreign network and/or restrict the subscriber's access to network services.

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Figure 1

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Figure 2

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(81) Designated States (*national*): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, UZ, VN, YU, ZA, ZW.

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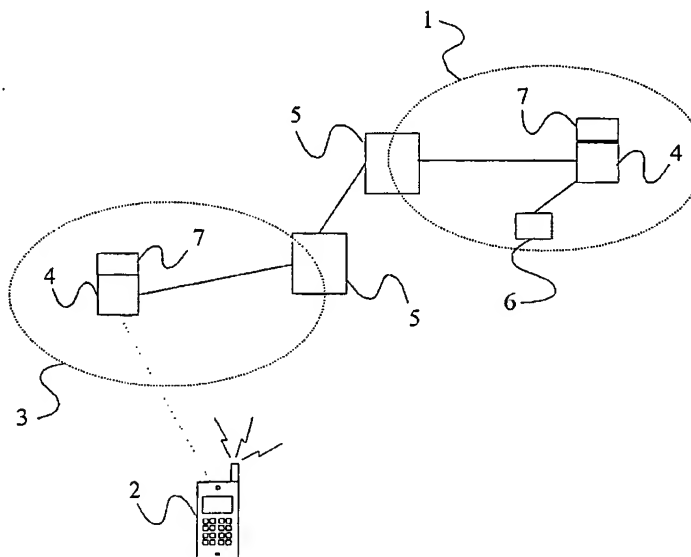
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INTERNATIONAL SEARCH REPORT

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A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H04M15/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 H04M H04Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, PAJ, WPI Data, INSPEC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 5 557 655 A (LANTTO SVEN J) 17 September 1996 (1996-09-17) column 4, line 14 -column 6, line 52 ---	1-7
Y	WO 93 11646 A (ELECTRONIC DATA SYST CORP) 10 June 1993 (1993-06-10) page 3, line 1 -page 4, last line page 7, line 4 -page 8, line 20 page 10, line 4 -page 11, line 7 page 12, line 14 -page 14, line 2 page 19, line 7 -page 21, last line ---	1-7
A	US 5 898 915 A (REININGHAUS GEORG ET AL) 27 April 1999 (1999-04-27) column 2, line 46 -column 3, line 37 column 3, line 8 -column 5, line 57 --- -/--	1,2,7

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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X document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

Y document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

G document member of the same patent family

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Name and mailing address of the ISA

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	<p>US 5 732 127 A (HAYES STEPHEN R) 24 March 1998 (1998-03-24) column 3, line 52 - line 57 column 4, line 3 - line 65 -----</p>	1-7 -

INTERNATIONAL SEARCH REPORT

Information on patent family members

Inventor's Application No
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